Claims

1. A composition comprising a liquid crystal material and an additive, preferably a dopant, wherein said additive is capable of forming a complex with said liquid crystal material.

2. The composition according to claim 1, wherein said liquid crystal material and said additive form a complex.

3. The composition according to claim 2, wherein said liquid crystal material and said additive form a complex, as measured by a method selected from the group comprising FTIR, UV-visible absorption, fluorescence, in particular polarized fluorescence, dielectric anisotropy and scanning near-field optical microscopy.

4. The composition according to any of the foregoing claims, wherein said liquid crystal material and said additive form a complex as simulated in MOPAC-simulations.

5. The composition according to claim 4, wherein said MOPAC-simulations comprise the following steps/conditions:
   in a computer environment,
   - providing a molecular structure of said liquid crystal material and a molecular structure of said additive,
   - optimizing each molecular structure individually by determining the lowest energy of formation, determining the AM1 and PM3 Hamiltonians and selecting the lowest energy molecular structure that is best fitted by both Hamiltonians,
   - bringing together the optimized individual molecules resulting from the previous step, allowing them to combine, taking into account the charges of atoms, the distribution of charges and the dipole moment of the molecular structures,
   - permutating the previous combination step a number of times, preferably in the range of from 100 – 1000 times, more preferably 200 – 800 times, even more preferably 400 – 600 times and most preferably about 500 times, thus allowing a complex, if any, of said liquid crystal material and additive molecules to form,
   - in such complex of molecules, optimizing the structure of the individual molecules so

as to determine the lowest energy of formation of the complex and the lowest energy state of the complex.

6. The composition according to claim 5, wherein said MOPAC simulations comprise the additional step:
   - selecting the complex having the lowest energy of formation and calculating from its structure the dipole moment.

7. A composition comprising a liquid crystal material and an additive, in particular according to any of the foregoing claims, wherein said additive is present in an amount of 0.01 – 0.15 wt.%, preferably 0.05 – 0.12 wt.%, more preferably 0.08 – 0.11 wt.% and most preferably around 0.1 wt.% of the total composition.

8. The composition according to any of the foregoing claims, wherein said additive, when viewed on its own, has no permanent dipole or a dipole $\leq$ 1 Debye, preferably $\leq$ 0.1 Debye.

9. The composition according to claim 8, wherein said additive gains a dipole in the presence of said liquid crystal material and, preferably, upon complex formation with said liquid crystal material.

10. The composition according to any of claims 7 – 9, wherein said additive is L20 (2,4-dichloro-3,6-diethoxybenzoquinone).

11. The composition according to any of claims 1 – 7, wherein said additive has a permanent dipole, preferably a dipole $\geq$ 1 Debye, more preferably $\geq$ 0.1 Debye.

12. The composition according to claim 11, wherein said complex formed by said liquid crystal material and said additive has a dipole which is greater than the sum of the individual dipoles of said liquid crystal material and said additive on their own.

13. The composition according to any of claims 11 – 12, wherein said additive is selected from the group comprising MORPIP (2-{4-[(2,6-dimethylmorpholin-4-yl)(4-methylpiperidin-1-yl)methylene]cyclohexa-2,5-dien-1-ylidene}malononitrile), J6, and 10-γP3CNQ.

14. The composition according to any of the foregoing claims, wherein said additive is a dye.

15. The composition according to any of the foregoing claims, wherein said liquid crystal material is selected from the group comprising MLC-2038, ZLI-1695, E7 and ZLI-4792.

16. The composition according to any of the foregoing claims, wherein said additive is soluble in said liquid crystal material.

17. The composition according to any of the foregoing claims, wherein said liquid crystal material has a permanent dipole.

18. The composition according to any of claims 1 – 16, wherein said liquid crystal material has an induced dipole.

19. The composition according to any of the foregoing claims, wherein said composition has an order parameter of at least 0.5, preferably of at least 0.7, wherein the order parameter S is defined as:

$$S = \frac{A_{\parallel} - A_{\perp}}{A_{\parallel} - A_{\perp}},$$

wherein $A_{\parallel}$ and $A_{\perp}$ are the measured absorbance values when the director axis of a liquid crystal or liquid crystal mixture is parallel ($A_{\parallel}$) or perpendicular ($A_{\perp}$) to the propagation axis of an incident polarized light, wherein, more preferably, a parallel state can be achieved by: in the case of a liquid crystal (LC) with positive dielectric anisotropy - inserting a liquid crystal or liquid crystal mixture in a parallel (or antiparallel, or homogeneous) aligned sandwiched cell; and either wherein a perpendicular state can be achieved by either applying an electric or magnetic field to such parallel (or antiparallel, or homogeneous) aligned cell, or alternatively by inserting the liquid crystal or liquid crystal mixture in a homeotropic (or perpendicularly, or vertically) aligned cell;
in the case of a LC with negative dielectric anisotropy - inserting a liquid crystal or liquid crystal mixture in a homeotropic (or perpendicularly or vertically) aligned sandwiched cell; and either wherein a parallel state can be achieved by either applying an electric or magnetic field to such homeotropic aligned cell, or alternatively by inserting the liquid

crystal or liquid crystal mixture in a parallel (or antiparallel, or homogeneous) aligned cell.

20. Use of a composition according to any of the foregoing claims in a liquid crystal cell for a liquid crystal display.

21. Use according to claim 20, wherein said liquid crystal cell is a single pixel cell or a multiple pixel cell.

22. Use according to any of claims 20 – 21 for improving the grey scale response time speeds of said liquid crystal cell and/or for shortening the rise and/or decay times of said liquid crystal cell.

23. A liquid crystal cell comprising the composition according to any of claims 1 – 19.

24. Use of a liquid crystal cell according to claim 23 in a liquid crystal display.

25. A method of improving the response time and/or the dielectric anisotropy and/or the grey scale response speed of a liquid crystal, preferably in a liquid crystal cell, comprising the steps:
    - providing a liquid crystal,
    - adding an additive to said liquid crystal, wherein said additive is capable of forming a complex with said liquid crystal.

26. The method according to claim 25, wherein said liquid crystal and said additive are as defined in any of claims 1 – 19.